

T

353

C44



Class T 353

Book .C 44

Copyright N^o

COPYRIGHT DEPOSIT.

NOTES ON MECHANICAL DRAWING

INTRODUCTORY TO MACHINE DESIGN

Arranged for Students in the

LEWIS INSTITUTE

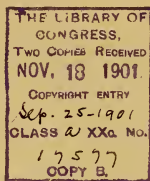
BY P. M. CHAMBERLAIN

CHICAGO, ILL.

1901.

THE LIBRARY
OF THE UNIVERSITY
OF CHICAGO

T353
C44



Copyrighted 1901
by P. M. Chamberlain.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	5
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	---

[illegible]

INTRODUCTORY NOTE.

It has been the aim for the five years since the Institute opened to start the students in machine drawing with as little dependence on text-books on drawing as possible, making the instruction largely individual. The practice of the best engineering concerns has been constantly scrutinized and the instructors in drawing have felt that some of the practice recognized as standard might be put in printed form to the advantage of all concerned. Messrs. Moseley, Hatch, Parker, Hawley, Barnay, and Barnum, who during this time have given instruction in drawing, have contributed suggestions which are embodied in the following pages. The tabulations given are few and the student is referred to Kent's Mechanical Engineer's Handbook, which should be on the table of every engineering student.

P. M. CHAMBERLAIN.

September, 1901.



NOTES ON MECHANICAL DRAWING.

In any drawing-room it may be observed that the **instruments** actually used are very few in number. It is therefore advised that the beginner start with only those most needed and, if possible, the best obtainable which are American or American Type Swiss Instruments.

The celluloid **triangles** are preferable to all others on account of their transparency and cleanliness. One $30^{\circ} \times 60^{\circ} \times 90^{\circ}$ about 8 inches long and one $45^{\circ} \times 45^{\circ} \times 90^{\circ}$ about 4 inches long are convenient sizes.

The **T square** should be slightly longer than the drawing board and without swivel head. One of good quality pear wood is quite satisfactory but more elaborate ones can be had. The head of the T square is apt to swell from a true surface where it slides along the edge of the board. This may be corrected by occasionally scraping away the bowed part.

The **compasses** should be the large size supplied with pencil and pen legs and adjustable needle point. **Large dividers** usually come with sets but are not very necessary. A set of **bow instruments**; bow dividers, bow pen and bow pencil, complete the necessary tools. The last two instruments may be had combined in one instrument whose needle point remains stationary while the pen or pencil leg is twirled around it.



This instrument, well made, is, for small circles, preferable to the old type of bow instruments.

The **pen** usually called the **right line** pen should be about six inches long and with spring blade but no hinge.

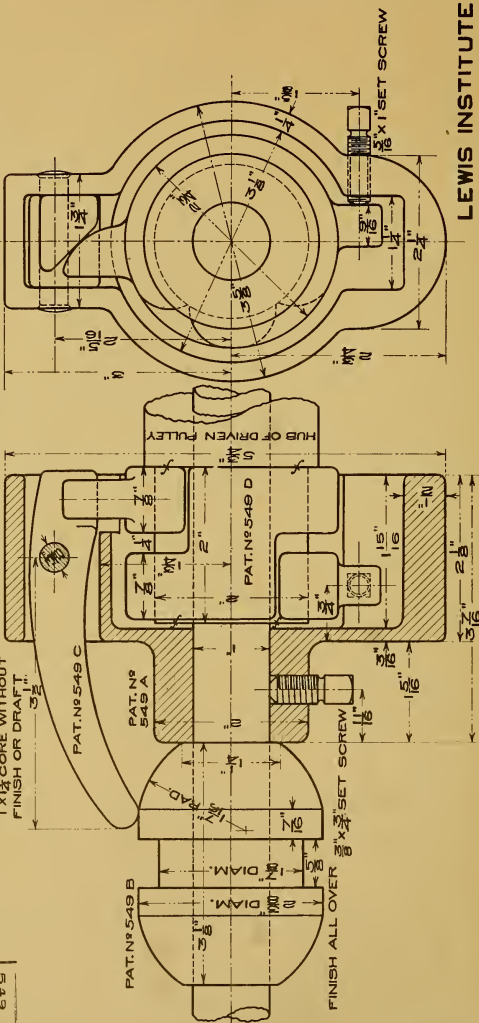


The catalogs of makers of, and dealers in, drawing instruments offer considerable information regarding the construction and care of instruments.

Higgins' water-proof **ink** is a standard liquid ink but usually is too thin when fresh. Evaporation soon brings it to the right consistency. Any ink will dry up at the pen point and clog the flow, hence it is necessary to wipe the pen out frequently with a piece of linen. Scraps of tracing cloth washed free from all starch make good **pen wipers**. It is not necessary to change the adjustment of the screw in the pen to clean it properly.

649

1" x 1/4" CORE WITHOUT
FINISH OR DRAFT.



LEWIS INSTITUTE
HUB FRICTION CLUTCH
DATE SEPT. 5 1901.
SCALE 12 3/4" = 1" No 549

The **scale** should be boxwood, steel, or boxwood covered with white celluloid. For machine drawings the proportions usual are 3 in. = 1 ft., whence $\frac{1}{4}$ in. = 1 in.; $1\frac{1}{2}$ in. = 1 ft., whence $\frac{1}{8}$ in. = 1 in.; or $\frac{3}{4}$ in. = 1 ft., whence 1-16 in. = 1 in. These divisions are readily found on any rule. The triangular architect's scale has these and other divisions, and is convenient to have, but troublesome to use, owing to the fact that the scale divisions wanted are usually the last found. A four-foot folding rule with white background is a most convenient thing to have in the pocket and is accurate enough for detail drawings which are to be traced.

For ordinary pencilling the **pencil** should have a long tapering screw-driver point, as shown in Figure 2.

The hardness of the pencil should be such as will enable the user to make with rapid strokes clear lines which can be erased without leaving depressions in the paper. Johann Faber's HHHH is recommended for detail paper.



FIG. 2

The **drawing-board** should have one edge straight and should be free from warp and wind. The various constructions can be observed in dealers' catalogs.

For most detail work a white or buff **drawing paper** with a sharp surface is desirable. As pencil drawings are seldom inked-in, the inking qualities need not be considered. It is desirable to have **sizes of drawings** conform to some standard. Where large quantities are consumed the paper is usually bought in rolls and a set of dimensions which may easily be remembered, and which cut to advantage, is preferable. If 36 inch paper is used, a standard of 24 inches by 36 inches is suggested. This may be doubled or divided into 2, 4, or 8 parts for smaller sizes, as shown in Figure 1.

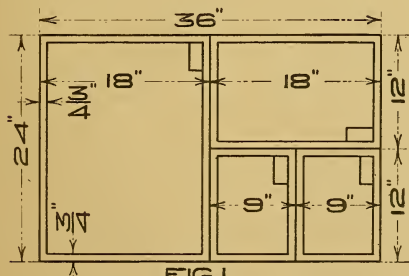


FIG. 1

Inside of the dimensions thus formed always lay off a **border line** $\frac{3}{4}$ of an inch from the edge. In making a tracing it is desirable to allow the cloth extra margin outside of the full dimensions of the standard as the edges of the tracing become curled

with much handling. The line of full size should be drawn to indicate on the blue print where to trim.

Standards for **center lines**, **dimension lines** and **witness lines** are found in some variety. Red ink lines which print faintly are sometimes used for each, but fine black lines with distinctive characteristics are for many reasons preferable. A dot and a dash for center lines, two dots and a dash for dimension lines, several dots and a full line for witness lines should be used in drawings made in connection with these notes. See page 6. **Arrow heads** should be large enough to indicate readily to what the dimension refers and may be made free hand, the width being about one-third the length. When the space for a dimension is too small to admit the arrow heads and dimension, the arrow heads may be placed pointing toward each other and the dimension placed outside.

In making a **tracing** it is usually best to ink-in first the small curves, then the larger ones, and then the straight lines, as it is easier to join a large curve or a straight line to a small curve than *vice versa*. The neatness of a tracing depends to a great extent on getting good **tangencies**. For those who cannot judge the proper junction with their eye it



FIG. 3

is advisable to draw a pencil line through the centers of the two curves, as shown in Figure 3, thus determining where they shall come together. In joining a curve to a straight line, the center used should lie on a perpendicular from the end. In joining a straight line to a curve, it should form a right angle with a radial line drawn to point of contact.

The making of **compound curves** is usually done with an "irregular curve," a scroll with a great variety of curves and seldom the one desired. The more satisfactory and quite as rapid method is to sketch in free-hand the desired curve and then locate sufficient centers to draw the curve with the compasses. See also in Figure 3. Greater economy of time may be had by tracing the curve free-hand but this should not be attempted until the more exact method is properly achieved.

In all drawings of cast parts there should be shown a **fillet** wherever there are two parts coming together at an angle. These should be made with a bow pen or bow pencil.

Cylindrical pieces are shown in section only when there is internal arrangement requiring it. All cylindrical surfaces and circles should have center lines indicated. The **material** to be used in construction may be indicated by some convention in cross-sectioning, but economy of time and clearness of expression are better served by using plain

hatching for all materials, and indicating by note, word, or initial the material. Where several pieces in contact are shown in section the hatch lines may contrast in direction or spacing if necessary, but always at forty-five degrees. Lines used in **hatching** should ordinarily be about 1-16 of an inch apart and as fine as the pen will properly make. There are many ingenious devices to facilitate equal spacing, but it is usually preferable to space by eye.

When a piece is to be machined or finished and it is not entirely obvious that such is the case, it is usual to place two letters along the projection of the finished surface. When parts are to be finished all over they may be marked **FINISH ALL OVER**.



The location of a **dimension** should always be such as will readily catch the eye of the mechanic and avoid all probable chance of confusion. The study of how a piece should be made in the shop is indispensable to good judgment in this very important consideration. This supposes that a designer is capable of directing every step of construction of that which he designs, as indeed he must be, to produce good designs and clear drawings. To be complete, a drawing must contain all dimensions and answer all questions that might arise to pattern maker, blacksmith, or machinist. Dimensions of more than 24 inches are usually expressed in feet and inches thus: 38" should be written 3'-2".

In **lettering**, the letter used should be one that can be quickly made, neat, and very easily read. For ease of acquirement and simplicity, the gothic letter, so called by printers, is satisfactory. Where a large letter is required, the following method will be found useful for making precise, uniformly spaced letters. See Figure 4. Lay off a line

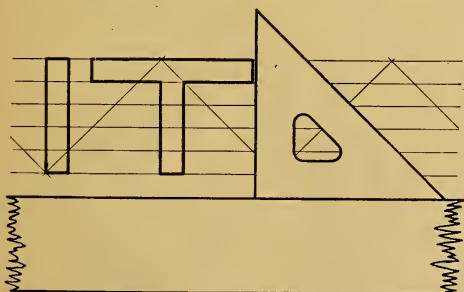


FIG. 4

for the top limit of the legend and beneath it a point at a distance equal to the desired height; divide this space into five equal parts by the eye. The first trial will likely be unsuccessful but a few trials should bring success. Through these points, or short lines, draw lines parallel to the top one. With the 45 degree triangle lay off oblique lines as shown. Take care that the angular lines meet exactly at the top and bottom lines. Allowing seven spaces for all letters excepting I, one

space between letters and four between words, calculate the total number of spaces needed and from the middle of the space allotted for the words, count to the left half the total spaces and begin laying off the upright lines of the letters at the intersection of the oblique with the parallel lines. This forms the outline of block letters which can easily be supplied with curves, the same centers serving for the inside



and outside curves. On page 11 is given the construction of all letters and figures of this scheme, and the same plan of spacing may be applied to the five space letter below. The word "letters" is given above in three sizes having exactly the same proportion, the smallest exhibiting what should be used for free-hand letters, which are made with the right line pen held upright and so adjusted that the width of the line is the same whichever direction the pen is moved, the pen not being turned from the position used for drawing horizontal lines. A standard height of 3-32" for all ordinary notes and dimensions is found desirable.

A B C D E F
G H J K L M
N O P Q R S
T U V W X Y
Z & 1 2 3 4
5 6 7 8 9 -



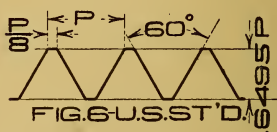
When the dimension of a radius is given it should be followed by the word **RADIUS** or abbreviation **RAD.** The arrow head should be placed at the outer end only, and if it is not evident where the center is, a very small circle may indicate it. The dividing line in a **fraction** should always be horizontal. Dimensions should read in the direction of the dimension line and from the bottom or right hand side of the sheet.

All parts shown threaded or tapped are understood to be the U. S. Standard for the size shown unless otherwise stated. The **screw threads** known as V shape, Sellers' or U. S. Standard, square and Powell will be here considered. The U. S. Standard is perhaps the most widely used, although the V thread is frequently found in commercial bolts, set screws and machine screws in the smaller sizes. Where the screw is used to transmit power, the square thread or the Powell thread should be used. The Powell thread has the advantage that the lash caused by wear may be corrected by closing up the nut.

The **V thread** has an angle of 60 degrees between sides of the thread. The depth of the thread is .866 of the pitch. See Figure 5.



The **Sellers' thread** has an angle of 60 degrees between threads. The top of the thread and the throat of the space are flattened one-eighth of the pitch. The depth is .6495 of the pitch. See Figure 6.



The **square thread** has a profile consistent with its name. The depth is one-half of the pitch.

The **Powell thread** has an angle of 29 degrees between the sides of the threads. The depth of thread is one-half the pitch. The flat is .3707 of the pitch. See Figure 7.



The term **pitch** means the distance the screw would travel longitudinally during one rotation, but is more frequently used to denote the distance from one point on a thread to the corresponding point on the profile of the adjoining one. The term is sometimes used to mean the number of threads per inch. The term is used in these notes with the second meaning.

In preparing to draw any style of thread, first lay out the limiting side lines and center line. Draw light cross lines at a distance apart equal to one-half of the pitch.

For the Sellers' thread, divide one of these spaces into four parts with the aid of the triangle, as in Figure 8, or by the eye, and draw

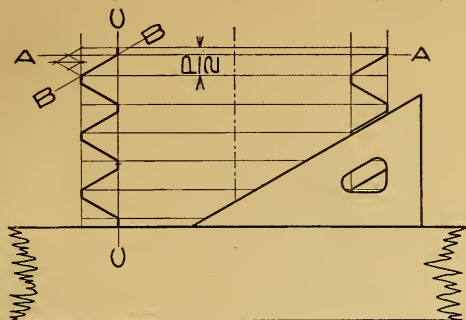


FIG. 8

across the figure a line through the proper point which is one-eighth of the pitch. With the 30 degree triangle draw the outlines of one side of a thread through the intersection of the last drawn cross line and the limiting side line; this will fix the position of the root lines. Points are thus fixed by intersections for all the threads.

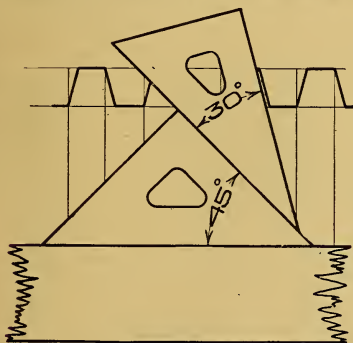


FIG. 9

To draw the Powell thread, lay off cross lines as before and root lines which may easily be located by aid of the 45 degree triangle. See Figure 9. With the two triangles obtain 15 degrees, this being near enough to the actual $14\frac{1}{2}$ degrees. Draw through the limiting lines, and the cross lines all the sides of threads corresponding to this position. In a similar way draw the other sides through the intersections of the cross lines and the root lines.

To draw the **helix**, locate points and whittle a templet from thin hard wood. To transfer the points to the wood, lay the wood against the edge of the T square just below the points. and with bow dividers measure the points off on the templet. The points may be determined by dividing a semi circle and half the pitch, into equal parts and finding the intersections of the projected divisions as in Figure 10. It is usually sufficient to obtain points from divisions of 1-16, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, $\frac{7}{8}$, and 15-16 of the semi-circle and rise.

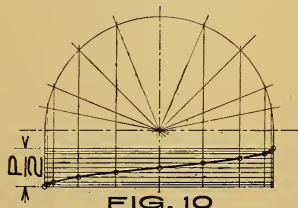


FIG. 10

On **double threads** the profiles on opposite sides of the screw are exactly opposite, in single threads a depression is opposite a full profile. See Figure 11. The lines representing the helical curves connecting the profiles are usually drawn straight.

It is seldom necessary to detail threads in this way and therefore certain **conventional threads** are used. The convention shown in Figure 12 may be used for sizes of $\frac{3}{4}$ " or larger. For sizes $\frac{3}{8}$ " to $\frac{3}{4}$ ", see Figure 13. For sizes under $\frac{3}{8}$ " see Figure 14.

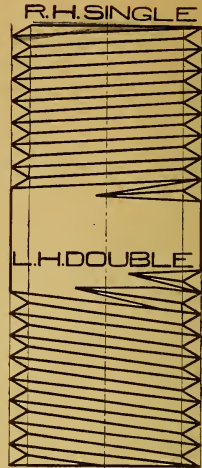
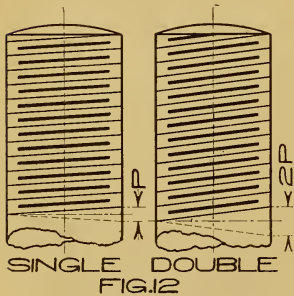


FIG. 11.



For drawing a detail of the standard **hexagon nut**, strike a temporary circle equal to the short diameter and with the 30-degree triangle put in the hexagon, projecting from it the two elevations. The chamfer marked C in the front elevation has no adopted standard but may be made 1-12 H in good proportion and at an angle with the horizontal of 30 degrees. See Figure 15. The projection of this chamfer gives the circle on the plan and it in turn the chamfer for the narrower elevation which is, of course, also 30 degrees. The height of the curves is located with a little ingenuity. The proportions for height and short diameter are also shown in Figure 15.

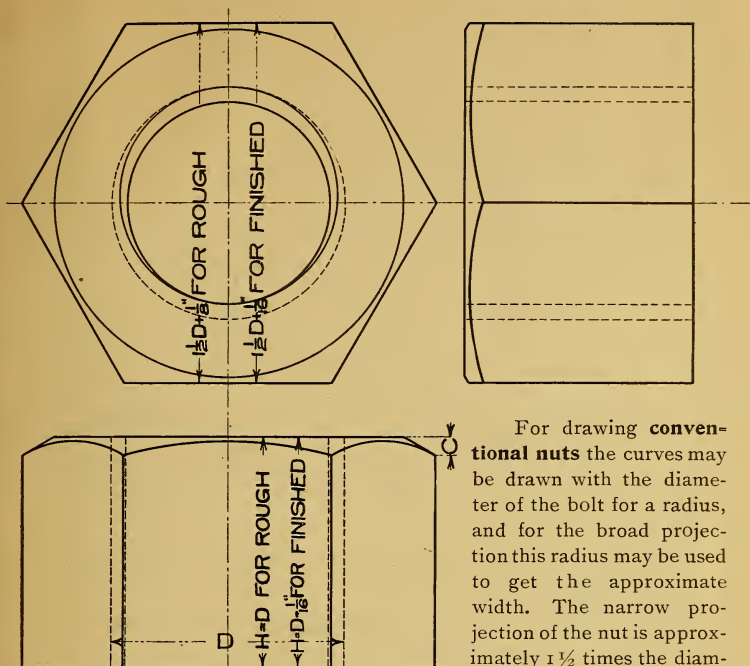


FIG. 15.

For drawing **conventional nuts** the curves may be drawn with the diameter of the bolt for a radius, and for the broad projection this radius may be used to get the approximate width. The narrow projection of the nut is approximately $1\frac{1}{2}$ times the diameter of the bolt.

Sizes of U. S. Standard threads, nuts and bolt heads are given with other data on page 16.

Set screws usually have heads equal in diameter and thickness to the diameter of the screw. The various forms of points are shown in Figure 16.

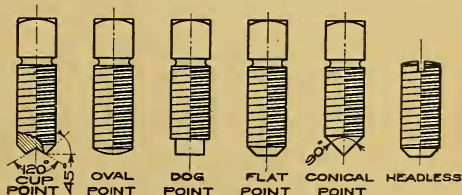





FIG. 16

Cap screws vary in proportion by different makers, but there is given on Page 17 a table compiled from the Chicago Screw Company's catalog. Up to 1" diameter they are threaded $\frac{3}{4}$ the length under the head, except the flat head which is threaded to the head.

DIAM. PER INCH	THDS PER INCH		BORE NEAREST 1/16" EXACT	ROUGH						FINISHED						SAFE STRAIN IN LBS.
				SHORT DIAM BOTH OF HEX.	LONG DIAM OF HEX.	THICK NESS NUTS	THICK NESS HEADS	SHORT DIAM. BOTH HEX.	LONG DIAM. OF SQ.	THICK NESS HEADS	THICK NESS NUTS	LONG DIAM. OF SQ.	DEPTH OF TH'D. FLAT	WIDTH OF FLAT		
1/4	22	0.167	1/16	3/32	3/32	1/16	1/16	1/16	3/32	3/32	3/32	1/16	1/16	0.056	286	
1/4	20	0.185	1/16	1/8	3/32	1/16	1/16	1/16	1/8	3/32	3/32	1/16	1/16	0.062	286	
5/16	18	0.2452	1/8	1/8	3/32	1/16	1/16	1/16	1/8	1/8	1/8	1/16	1/16	0.069	452	
5/16	16	0.2988	1/8	1/8	1/2	1/16	1/16	1/16	1/8	1/8	1/8	1/16	1/16	0.078	677	
3/8	14	0.3447	1/8	1/8	1/2	1/16	1/16	1/16	1/8	1/8	1/8	1/16	1/16	0.089	932	
3/8	13	0.4001	1/8	1/8	1	1/16	1/16	1/16	1/8	1/8	1/8	1/16	1/16	0.096	1257	
1/2	12	0.4542	1/8	1/8	1 1/2	1/16	1/16	1/16	1/8	1/8	1/8	1/16	1/16	0.104	1620	
1/2	11	0.5069	1/8	1/8	1 1/2	1/16	1/16	1/16	1	1/8	1/8	1/16	1/16	0.114	2018	
5/8	10	0.6201	1/8	1/8	1 1/2	1/16	1/16	1/16	1 1/2	1/8	1/8	1/16	1/16	0.125	3020	
5/8	9	0.7307	1/8	1/8	2 1/2	1/16	1/16	1/16	1 1/2	1/8	1/8	1/16	1/16	0.159	4104	
1	8	0.8376	1/8	1/8	2 1/2	1/16	1/16	1/16	1 1/2	1/8	1/8	1/16	1/16	0.156	5509	
1 1/8	7	0.9394	1/8	1/8	2 1/2	1/16	1/16	1/16	1 1/2	1/8	1/8	1/16	1/16	0.179	6930	
1 1/4	7	1.0644	1/8	1/8	2 1/2	1/16	1/16	1/16	1 1/2	1/8	1/8	1/16	1/16	0.179	8990	
1 1/2	6	1.1585	1/8	1/8	3 1/2	1/16	1/16	1/16	2 1/2	1/8	1/8	1/16	1/16	0.208	10540	
1 3/4	6	1.2835	1/8	1/8	3 1/2	1/16	1/16	1/16	2 1/2	1/8	1/8	1/16	1/16	0.209	12935	
1 5/8	5 1/2	1.3868	1/8	1/8	3 1/2	1/16	1/16	1/16	2 1/2	1/8	1/8	1/16	1/16	0.227	17441	
1 3/4	5	1.4902	1/8	1/8	3 1/2	1/16	1/16	1/16	3 1/2	1/8	1/8	1/16	1/16	0.250	23000	
1 7/8	5	1.6152	1/8	1/8	4 1/2	1/16	1/16	1/16	3 1/2	1/8	1/8	1/16	1/16	0.250	30214	
2	4 1/2	1.7115	1/8	1/8	4 1/2	1/16	1/16	1/16	3 1/2	1/8	1/8	1/16	1/16	0.278	37149	

DIAM. OF SCREW							
3-8	DIAM. OF HEAD	3-8	5-16	1-4	3-8	1-4	5-16
3-16	HEIGHT OF HEAD	3-16	5-32	3-16	3-16	3-16	3-16
24	THREADS PER IN.	24	24	24	24	24	24
4-4	DIAM. OF HEAD	7-16	7-16	3-8	15-32	3-8	3-8
1-4	HEIGHT OF HEAD	1-4	7-32	1-4	1-4	1-4	1-4
20	THREADS PER IN.	20	20	20	20	20	20
5-16	DIAM. OF HEAD	1-2	9-16	7-16	5-8	7-16	7-16
5-16	HEIGHT OF HEAD	5-16	9-32	5-16	5-16	5-16	5-16
18	THREADS PER IN.	18	18	18	18	18	18
9-16	DIAM. OF HEAD	9-16	5-8	9-16	3-4	9-16	1-2
3-8	HEIGHT OF HEAD	3-8	5-16	3-8	3-8	3-8	3-8
16	THREADS PER IN.	16	16	16	16	16	16
5-8	DIAM. OF HEAD	5-8	3-4	5-8	13-16	5-8	9-16
7-16	HEIGHT OF HEAD	7-16	3-8	7-16	7-16	7-16	7-16
14	THREADS PER IN.	14	14	14	14	14	14
3-4	DIAM. OF HEAD	3-4	13-16	3-4	7-8	3-4	5-8
1-2	HEIGHT OF HEAD	1-2	13-32	1-2	1-2	1-2	1-2
12	THREADS PER IN.	12	12	12	12	12	12
13-16	DIAM. OF HEAD	13-16	13-16	13-16	1	13-16	11-16
9-16	HEIGHT OF HEAD	9-16	15-32	9-16	9-16	9-16	9-16
12	THREADS PER IN.	12	12	12	12	12	12
7-8	DIAM. OF HEAD	7-8	1	7-8	1-1-8	7-8	3-4
5-8	HEIGHT OF HEAD	5-8	1-2	5-8	5-8	5-8	5-8
11	THREADS PER IN.	11	11	11	11	11	11
15-16	DIAM. OF HEAD	15-16	1	15-16	1-1-4	15-16	13-16
11-16	HEIGHT OF HEAD	11-16	1-2	11-16	11-16	11-16	11-16
11	THREADS PER IN.	11	11	11	11	11	11
1	DIAM. OF HEAD	1	1-1-4	1	1-3-8	1	7-8
3-4	HEIGHT OF HEAD	3-4	5-8	3-4	3-4	3-4	3-4
10	THREADS PER IN.	10	10	10	10	10	10
1-1-16	DIAM. OF HEAD	1-1-16	1-3-8	1-1-16	1-1-2	1-1-16	1-1-16
13-16	HEIGHT OF HEAD	13-16	11-16	13-16	13-16	13-16	13-16
10	THREADS PER IN.	10	10	10	10	10	10
1-1-8	DIAM. OF HEAD	1-1-8	1-1-2	1-1-8	1-1-2	1-1-16	1-1-16
7-8	HEIGHT OF HEAD	7-8	3-4	7-8	9	13-16	13-16
9	THREADS PER IN.	9	9	9	9	9	9
1-3-16	DIAM. OF HEAD	1-3-16	1-9-16	1-3-16	1-1-16	1-3-16	1-3-16
15-16	HEIGHT OF HEAD	15-16	25-32	15-16	15-16	15-16	15-16
9	THREADS PER IN.	9	9	9	9	9	9
1-1-4	DIAM. OF HEAD	1-1-4	1-5-8	1-1-4	1-13-16	1-1-4	1-1-4
1	HEIGHT OF HEAD	1	13-16	1	1	1	1
8	THREADS PER IN.	8	8	8	8	8	8

In indicating a **threaded hole** use the convention shown in connection with the 5-16" x 1" set screw on page 6, which is simple and clear. In cases where the screw is not shown, or where only an end view is given it should be marked **TAP 2"**, etc.

Where the material is shown in section as in connection with the $\frac{3}{8}$ " x $\frac{3}{4}$ " set screw on page 6, the threading of the casting is indicated. Where it is desired to indicate that the casting is not threaded, a clearance shown between screw and casting accomplishes it.

When duplicate parts are required, mark the drawings **2 OF THIS** or **3 OF THIS**, or **MAKE 2** or **MAKE 3**, etc.

When a **taper** is required the drawing should be marked with the taper per foot of length; thus a taper of $\frac{3}{4}$ " per foot means a total decrease of diameter or width of $\frac{3}{4}$ " for each foot of length, and in that proportion for shorter lengths. When a taper is determined by given dimensions at each end of a given length, the approximate taper per foot should be given and marked **APPROX. TAPER**.

Mark all cast parts with a **pattern number** consisting of the drawing number followed by a distinguishing letter as shown on page 6.

LEWIS INSTITUTE

DATE

SCALE

IN=1 FT No



FIG. 17.

The **title, drawing number, date, etc.**, should be in the lower right hand corner, lengthwise of the sheet. See Page 6. The number should also be placed in the upper left hand corner upside down so that in looking over a pile of drawings for a certain number, it can be readily found, even though some of them may be upside down. The title should ordinarily state first the firm name; second, the machine or structure to which the drawing pertains; third, the distinctive title of the particular drawing; fourth, the date; fifth, the scale; sixth, the serial number of the drawing. Those parts of a title which occur on every drawing should be of a standard style and size. This may be obtained by having the tracings printed on a press, by using a rubber stamp, or by having a copy which can be copied or traced. A rubber stamp does not give an impression that will print well and should be filled in with ink if used on a tracing. The title used at Lewis Institute is shown in Figure 17.

The **tabulations** on pages 16 & 17 give examples of work that students may indulge in to great improvement of their skill in making

figures and letters. The ability to do neat lettering is of prime importance to a draftsman.

In **tracing**, the picture lines should be nearly 1-32 of an inch wide and cross section, witness, centre, dimension, and dotted lines as light as can be neatly made. Arrow heads should be distinct and quite acute. All lettering and dimensioning should be distinct and uniform in size. The drawing pen should be used for making figures and letters. The glossy side of the tracing cloth should be used, and well chalked before inking.

In case of necessity of **erasure**, use a piece of talc crayon to restore gloss to the cloth. Never use a knife to erase as the ink will soak into the cloth where this is done. A tracing should not be commenced until the pencil drawing is complete and checked.

Figure 18 shows a **free hand sketch** of a head stock and exhibits a class of accomplishment which every draftsman should cultivate. A preliminary sketch thus made gives all data necessary for the production of a mechanical drawing.

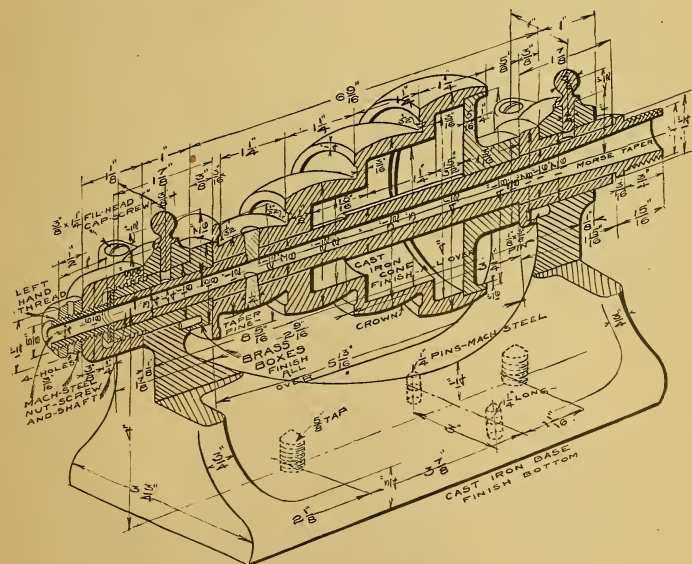
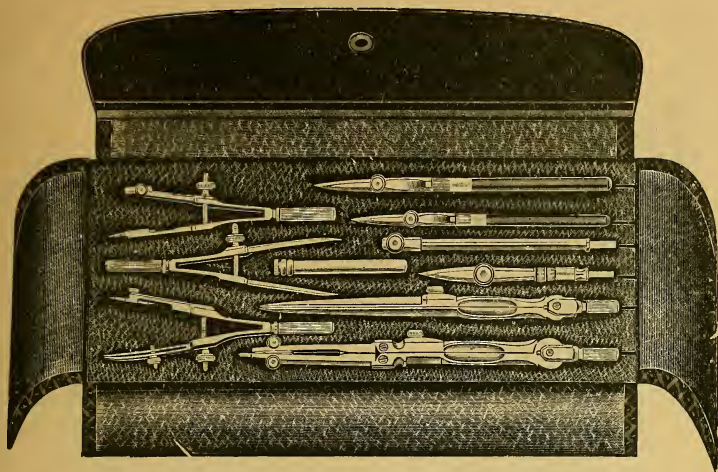


FIG. 18.

DECIMAL EQUIVALENTS OF FRACTIONS.

1 64	015625	17 64	265625	33 64	515625	49 64	765625
1 32	03125	9 32	28125	17 32	53125	25 32	78125
3 64	046875	19 64	296875	35 64	546875	51 64	796875
1 16	0625	5 16	3125	9 16	5625	13 16	8125
5 64	078125	21 64	328125	37 64	578125	53 64	828125
3 32	09375	11 32	34375	19 32	59375	27 32	84375
7 64	109375	23 64	359375	39 64	609375	55 64	859375
1 8	125	3 8	375	5 8	625	7 8	875
9 64	140625	25 64	390625	41 64	640625	57 64	890625
5 32	15625	13 32	40625	21 32	65625	29 32	90625
11 64	171875	27 64	421875	43 64	671875	59 64	921875
3 16	1875	7 16	4375	11 16	6875	15 16	9375
13 64	203125	29 64	453125	45 64	703125	61 64	953125
7 32	21875	15 32	46875	23 32	71875	31 32	96875
15 64	234375	31 64	484375	47 64	734375	63 64	984375
1 4	25	1 2	5	3 4	75		

LEWIS INSTITUTE
 GEORGE A. LEWIS, PRESIDENT
 1010 NORTH WABASH
 CHICAGO, ILL.



A. H. ABBOTT & CO.

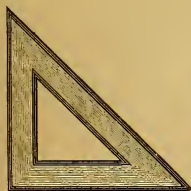
...DRAWING MATERIALS...

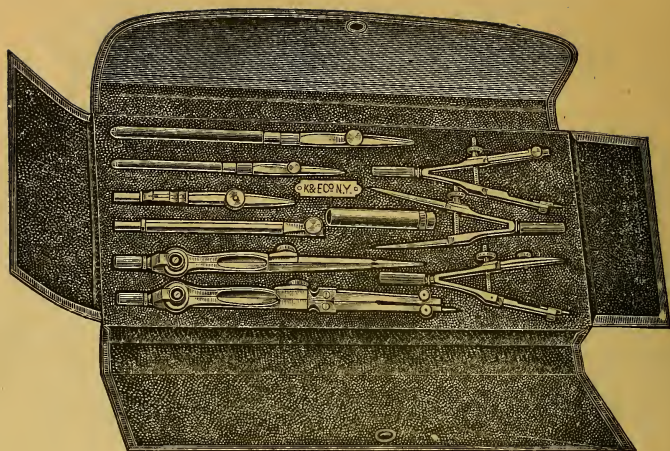
48 MADISON STREET, CHICAGO.
BETWEEN STATE STREET AND WABASH AVENUE.

TELEPHONE MAIN 2429.

MATHEMATICAL
AND SURVEYING
INSTRUMENTS

SUPPLIES FOR SCHOOLS
AND ARCHITECTS,
CIVIL AND MECHANICAL
ENGINEERS.





KEUFFEL & ESSER CO.

OF NEW YORK.

DRAWING MATERIALS

SURVEYING INSTRUMENTS

III E. Madison Street, Chicago.

Between Clark and Dearborn Sts.

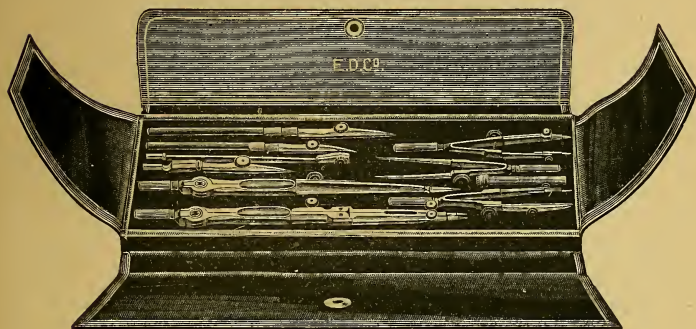
LIBERAL DISCOUNTS TO STUDENTS.

L. of C.

GEM UNION INSTRUMENTS

SUPERIOR TO ALL OTHERS IN

Construction, Material and Finish.



"UNION" PIVOT JOINT

Strongest and most durable joint made. Warranted to last a lifetime.

Most complete assortment of

DRAWING MATERIALS

IN THE WEST

EUGENE DIETZGEN COMPANY

181 MONROE STREET, CHICAGO

Catalogue on application.

NOV 18 1901

H. & C. WOLFE

776 W. Madison St.

Lewis Institute Building

DEALERS IN

....*Drawing Instruments*....

AND MATERIALS

Such well known makes of Instruments as ALTENEDER'S and DEITZGEN'S
carried in stock.

*Our prices are always a little lower than down town. Remember we
are right in the Lewis Institute Building.*



You need a keen cutting Knife
in your work.

We carry some of the world's best brands—

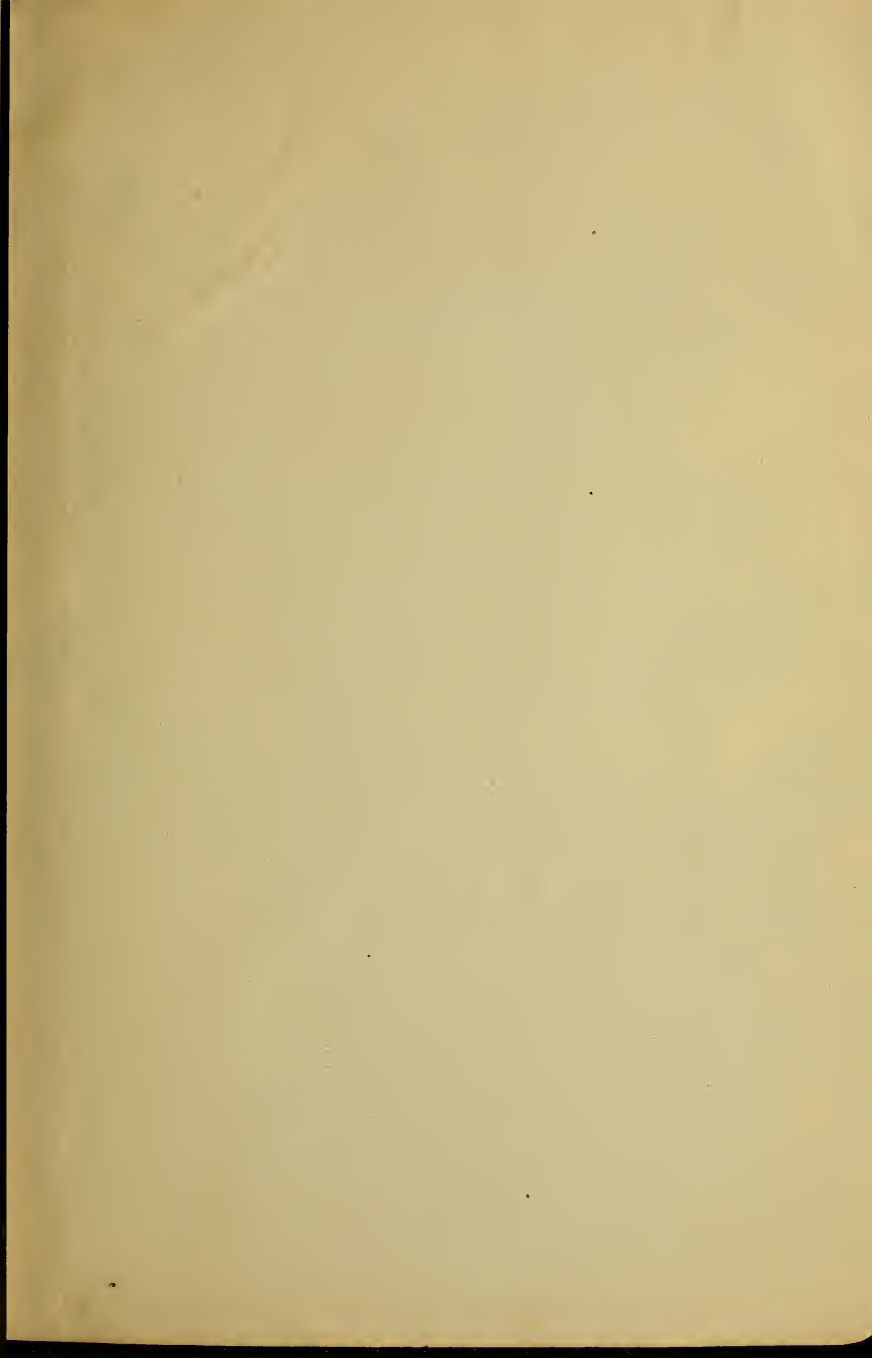
**Geo. Wostenholm's
Jos. Rodgers & Son's
and Empire Knife Co.**

We carry all the standard tools for Manual Training
Schools.

**Sheldon's Rapid Acting Vices,
Work Benches, Etc. . . .**

ORR & LOCKETT HARDWARE CO.

71-73 RANDOLPH STREET, CHICAGO.



LIBRARY OF CONGRESS



0 019 945 291 5